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LASER-INDUCED THERMOTHERAPY (LITT) COMBINED WITH HEPATIC ARTERIAL EMBOLIZATION INCREASES THE EFFICACY OF LITT IN THE TREATMENT OF LIVER METASTASES.

Isbert C[1], Germer CT[1], Ritz JP[1], Roggan A[2], Pelz J[1], Müller G[2], Buhr HJ[1]

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Purpose: Laser-induced thermotherapy is a promising in situ ablation technique for malignant liver tumors. The aim of the study was to assess the effect of combined laser-induced thermotherapy (LITT) and hepatic arterial embolization with degradable starch microspheres (DSM) on tumor response and intrahepatic temperature distribution in rats with liver tumors. Methods: Colon carcinoma CC531 was implanted in 60 WAG rat livers. Fourteen days later, a silicon catheter was implanted in the hepatic artery for DSM administration. Tumors were exposed to 1064 nm Nd:YAG laser light at 2 watts for 10 minutes from a diffuser-tip applicator placed in the tumor. The animals were randomized into a sham-operated control (group I) and three test groups. Group II received DSM alone, group III received LITT alone, and group IV received DSM + LITT. Tumor control was examined 1, 7, and 14 days after treatment. Results: A complete tumor remission was achieved in all rats treated with LITT + DSM (group IV). In contrast, tumor progression was seen in animals treated with LITT alone (group III) or DSM alone (group II), as well as in the sham-operated controls (group I). Conclusion: The authors' results suggest that the combination of LITT and DSM considerably increases the efficacy of LITT in the treatment of liver metastases in the rat.

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Low dose Photodynamic Therapy for chest wall malignancies.

T.S. Mang, R.R. Allison Buffalo General Hospital

Purpose: We report the feasibility of lowering photosensitizer drug dose as a means of exploiting photobleaching kinetics to improve therapeutic ratio in patients with recurrent breast carcinoma emanating as cutaneous malignancies.

Methods: A total of 102 chest wall sites were treated with PDT following failure of multimodality salvage therapy. In these 9 patients, lesion size ranged from 0.57 to 9 cm. PDT consisted of outpatient infusion of 0.8 mg/kg, Photofrin, followed 48 hrs post with 630 nm light, delivered via lens fiberoptics, from a KTP:YAG/dye laser. Doses were in the 135-170 J/cm^2 range, delivered using 50-175 mw/cm^2 dose rates.

Results: Despite all patients having failed surgery, full dose radiation, and multiagent chemotherapy, 89% of lesions responded fully (complete response). Reduction of lesion size occurred in 8% of lesions with a 3% no response rate. Lesions also healed without scarring.

Conclusions: Results demonstrate that drug and light dose parameters can be altered to exploit photobleaching and improve therapeutic ratios. Patients who have received multi-agent therapy often show enhanced PDT response. Taking advantage of drug and light dose parameters can alleviate tumors and unwanted normal tissue damage.

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PHOTODYNAMIC THERAPY (PDT) FOR TREATMENT OF SUPERFICIAL ORAL CAVITY AND LARYNGEAL CANCER, AND HEAD AND NECK CUTANEOUS BCCa AND SqCCa

Vanessa G. Schweitzer

Department of OTO-HNS, Henry Ford Health System, Detroit, MI

Twenty cases of superficial diffuse field cancerization of the oral cavity and Tis-T1N0M0 and T2N0M0 laryngeal malignancies that failed conventional therapy (wide local surgical excision, CO2 laser ablation, external beam radiation therapy), and twelve cases of aggressive recurrent BCCa and SqCCa of the head and neck were treated with PHOTOFRIN-mediated photodynamic therapy (PDT).

Intravenous PHOTOFRIN (porfimer sodium) (dose 1.0 or 2.0 mg/kg) was administered, followed 48-60 hours later by intraoperative light photoactivation at 630 nm via microlens and/or cylindrical diffuser fiberoptic delivery. Five of the cases of head and neck cutaneous BCCa and/or SqCCa required concomitant wide local surgical resection with intraoperative PDT to the tumor bed resection site and skin periphery.

Complete responses were achieved in 9 of 10 patients with superficial diffuse field cancerization of the oral cavity and eight of ten patients with laryngeal malignancies, followed 1 year post PDT treatment. Biopsy proven complete responses and excellent cosmetic results were achieved in nine of twelve patients with recurrent cutaneous BCCa and SqCCa of the head and neck.

PHOTOFRIN-mediated PDT provides a nondisfiguring oncologic modality for curative treatment of early stage oral cavity and laryngeal malignancies with preservation of voice quality and oral function, and multiple drug and laser light retreatment capability. Photodynamic therapy could obviate radiation therapy for superficial Tis-T1N0M0 laryngeal carcinoma, thus reserving radiation therapy for treatment of second primary head and neck malignancies. PHOTOFRIN-mediated PDT is also an excellent adjunct oncologic treatment for BCCa and SqCCa resulting from local recurrent or persistent temporal bone / parotid cancer, solar damaged or latent radiation therapy-induced recurrent facial skin cancers, and multiple recurrent skin lesions recalcitrant to MOH's microsurgery.

PLENARY SESSION

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BASIC SCIENCE/OPTICAL DIAGNOSTICS

J. Stuart Nelson, Beckman Laser Institute and Medical Clinic, University of California, Irvine, Irvine, CA

Light was perhaps the very first diagnostic tool. Light has always been used to investigate the exterior of the body, but since the 1920's, it has also been used to probe interior organs and tissues. Optical techniques are attractive because they are non-invasive, utilize non-

ionizing radiation and are often technologically simple. These features have led to compact, portable and inexpensive clinical instruments that provide measurements which can be easily interpreted by physicians and other paramedical personnel. The nearly universal acceptance of pulse-oximeters is an important, illustrative example of how optical methods can have a dramatic impact on the clinical management of patients. This presentation is intended to provide the practitioner with an up to date review on the development of remote optical and thermal sensing techniques and their role in the clinical management of patients.

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Biostimulation. John A. Goldman, MD, Emory University School of Medicine

Biostimulation is a continuous area for investigation. Theoretically there is a basis that cellular elements and/or chromophores at the cellular level would be stimulated or suppressed by various light wavelengths. Laser is a unique tool to deliver such individual wavelengths. If laser has such a role there are still many questions that need to be answered. We need to:

1. Understand the role of basic mechanisms of low level laser biostimulation
2. Understand the clinical database that supports the role of low level laser biostimulation
3. Correlate the basic science studies with the clinical studies to see if there is a role for low level laser biostimulation.

While basic science indicates stimulation or inhibition at the cellular level, we have not seen dramatic clinical responses to laser even when tested against placebo. Beyond that, other conventional therapies are as effective or more effective when tested against laser in clinical protocols and these are much less expensive and less time consuming than some of the very elaborate laser systems. The parameters of lasing are still variable and there are endless options of time, intensity, wavelength and type of lasing that can be applied. Finding the correct parameters if they exist has been the goal. This has been applied using theoretical approaches extrapolated from countless investigational studies, but to date we have been more Quixotic than successful in this arena. This may suggest that there needs to be some new approaches to this field to help harness the potential of the laser biostimulation. Some areas I suggest we consider include:

1. Heat – we always suggest that low level therapy may work by mechanisms other than the heat generated. I suggest we accept that heat occurs and be certain we measure its levels when studies are done. Lack of heat or too much heat may help or hinder the results. We know that light energy can be generated into heat. Let's accept that and include it. If we find that laser help is due wholly or in part to heat generated then we will know. Since we don't measure it we don't know.
2. Energy level – low level may be too low. What is low and what is not low? We may be aiming too low and therefore not exploring higher energy levels where we may find clinical results.

These are a few observations which I submit in this continuing field.

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LASER IN CARDIOVASCULAR MEDICINE — HIGHLIGHTS

On Topaz. Division of Cardiology, McGuire VA Medical Center and Virginia Commonwealth University, Medical College of Virginia, Richmond, VA USA

The main focus of applications of laser in cardiovascular medicine over the last three years include: (1) transmyocardial revascularization; (2) pacemaker lead extraction; (3) revascularization of stenosed stents; (4) treatment of heart transplant recipients; (5) treatment of acute coronary syndromes, i.e. acute myocardial infarction and unstable angina.

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LASERS IN DENTISTRY

Martha Cortes, New York, NY

Dental lasers have come into their own in the last few years by the many benefits it offers the dental community. Many lasers are now used for the whitening of stained and dark teeth because of their inherent speed and efficiency in bleaching teeth. The laser also lends itself to high speed curing of composites, adhesives and other related materials. Gingivectomies, gingivoplasty crown lengthening, and pontic remodeling are easily performed with dental lasers. Lasers allow for precision, hemostasis, and homeostatis in an environment where antisepsis and bactericidal effects are part and parcel of their intrinsic function; essential in the removal of periodontal diseases, which are now known to contribute to systemic diseases such as diabetes and conorary heart disease.

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Dermatology and Plastic Surgery-Parade of Specialties

Jeffrey S. Dover M.D., FRCPC, Kenneth A. Arndt, M.D.
Beth Israel Deaconess Medical Center, Harvard Medical School

Among the many developments in cutaneous laser surgery, there are four that standout:

Laser hair removal: Using long pulsed lasers in the millisecond domain, selective hair follicle disruption successfully induces hair growth reduction. Many wavelengths and technologies are effective, but no optimal device has yet been identified. The mechanism appears to be a combination of hair miniaturization and hair follicle destruction.

Skin rejuvenation: Pulsed CO_2 and Erbium:YAG lasers are highly successful for altering the texture and composition of skin of patients with sun-induced skin damage (rhytids) and acne scarring. Problems in wound healing and potential risks of pigmentary change and scarring have stimulated interest in other means of skin rejuvenation. Electro-surgical devices are being developed for skin ablation while selective dermal collagen remodeling and regeneration are being studied with long pulsed Nd:YAG sources.

Laser treatment of vascular lesions: By increasing the pulse duration from the microsecond to the millisecond domain (1 to 50 msecs) and lengthening wavelengths absorbed by hemoglobin even better selective vascular damage with less or no purpura can be achieved when treating vascular lesions. Even longer wavelengths of 755 nm, 810 nm, or 1,064 nm combined with ms long pulse durations appear to be effective in treating leg veins 0.4 to 2 mm in diameter.

Cooling offers the opportunity to protect the epidermis and limit collateral thermal effects while selectively damaging dermal structures. The first studies were performed using contact or dynamic spray cooling to treat vascular lesions while newer studies have evaluated the use of cooling in laser skin resurfacing.

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LASERS IN GASTROENTEROLOGY, GENERAL SURGERY AND GYNECOLOGY: A STATUS REPORT

RJ Lanzafame, Laser Center, Rochester General Hospital, Rochester, NY

Purpose: This presentation examines the utilization of laser technology in gastroenterology, general surgery and gynecology over the past

three years and discusses recent developments in these specialties. Future trends and opportunities are discussed.
Methods: Recent developments and the utilization of lasers was examined for gastroenterology, general surgery and gynecology. The MEDLINE® database was scanned to determine the number of scholarly publications in these disciplines between 1/1/97 and 10/1/99. The nature of the topics covered was determined. A questionnaire was sent to 300 members of ASLMS, who are listed as general surgeons, in an effort to assess the current utilization of lasers by general surgeons and to assess the future needs of this group regarding these technologies. An analysis of the actual laser procedures performed at a designated laser center was completed for the same period. These results are contrasted to the trends exhibited in the recent scientific literature and the survey results from the ASLMS membership.
Results: Of 2035 published articles between 1997 and 1999, only 20 papers dealt with general surgery, gastroenterology, laparoscopy or gynecology. New applications include interstitial therapy for fertility and endometriosis, in-situ diagnosis for H. pylori infection, and veterinary applications. Concerns regarding vaporized tissue plume, anesthetic concerns and their relationship to laparoscopic procedures were the main focus of 5 papers and were topics mentioned in several others. Analysis of actual laser procedures performed at RGH during a similar period documents that laser use by these specialties is ongoing and is relatively stable. The results of the ASLMS laser use survey will be presented.
Conclusion: Although novel uses of laser technology are developing slowly in these specialties, lasers are indeed being used by gastroenterologists, general surgeons and gynecologists. Opportunities exist for future applications in these areas.

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PARADE OF SPECIALITIES
"Current Applications of Lasers in Neurosurgery"
Stephen K. Powers, M.D., F.A.C.S.

The precision that lasers offer neurosurgeons for cutting, coagulating and vaporizing tissues have made them especially versatile as an adjunctive tool for microsurgical procedures in the brain and spine. During the past decade we have seen the evolution of minimally invasive techniques that employ endoscopic visualization of target tissues in the brain and spine. With the growth of craniospinal endoscopy the various wavelength lasers have contributed to the diagnosis and the treatment of benign as well as malignant lesions. The availability of laser energy through limited openings via fiberoptic transmission enables neurosurgeons to cut, to coagulate, to shrink and to remove tissue by way of vaporization to effect treatment Thus, tumors, intracranial cysts and herniated spinal discs, for example, can be treated through dime-sized openings.

Low energy non-thermal lasers are used for fluorescence detection of brain tumors, photodynamic therapy of brain tumors and, also, may be beneficial for relieving pain and augmenting neural regeneration.

The state of the art neurosurgical procedures employ MRI and/or CT image guidance with minimally invasive technic using either endoscopy alone or endoscopically assisted microsurgery usually with the aid of laser(s) in order to minimize pain and injury of the patient.

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PARADE OF SPECIALTIES - NURSING ALLIED HEALTH
Patti Owens
Providence St. Peter Hospital, Olympia, Washington

As we enter the new millennium, it is time to reflect on the evolution of this section from neophytes to advance practitioners in the field of laser technology. This division has embodied the values of quality patient care, safety, effectiveness, education and advancement of patient outcomes. Nurses and allied health members have become team members with physicians, business entrepreneurs, educators, research coordinators, and Internet webmasters. This brief presentation will highlight conference abstracts in our division and what the future may hold.

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Title: Ophthalmic Lasers for the Next Millennium
Author: Carmen A. Puliafito, MD - New England Eye Center, Tufts University School of Medicine, Boston, Massachusetts

Purpose: Review applications of laser technology
Method: Uses in glaucoma, macular degeneration and refractive disorders
Results/Conclusion: Ophthalmology, the first medical specialty to embrace lasers can be used to expand its application of laser technology. In the year 2000, it is estimated that 1.3 million laser vision correction procedures using the excimer laser will be performed in the United States. Photodynamic Therapy (PDT) of choroidal neovascularization associated with age-related macular degeneration is expected to be approved for widespread clinical use at the beginning of the next year. It is certain that PDT of macular degeneration will rapidly become not only the most widely used photodynamic interaction in all of medicine, but become the most successful treatment of the leading cause of blindness in the industrial world. New laser technologies for treatment of glaucoma, including selective laser trabeculoplasty SLT, with the short-pulsed green Nd YAG laser show extraordinary promise as well.

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PARADE OF SPECIALTIES
Section on Otolaryngology and Pulmonary Applications
Udayan K. Shah, MD
The Children's Hospital of Philadelphia
Philadelphia, PA
Otolaryngology and Pulmonary applications exemplify the advancements in laser medicine and surgery. Improvements in delivery technology have led to compact systems for laser myringotomy and stapedotomy. Diode lasers are being investigated for otologic, rhinologic, and airway applications. The growing understanding of optical diagnostics, for mucosal lesions of the aerodigestive tract, is well represented in this Section. Laser technology remains indispensable for the management of many airway disorders, with novel wavelengths and delivery systems promising further refinements in this critical field.

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LASERS IN VETERINARY MEDICINE – UPDATE 2000

Kenneth E. Bartels, College of Veterinary Medicine, Oklahoma State University, Stillwater, OK

The use of lasers in veterinary medicine has expanded dramatically in the past 3 years. Development of more compact and affordable carbon dioxide and diode lasers has opened the door to surgical laser technology for practitioners in both small and large animal specialties. Photothermal ablation of tumors and other pathologic tissue has revolutionized certain treatment modalities in many different species. In addition, practitioners have used lasers to upgrade more "routine procedures" such as feline onychectomies so they are less painful for the animal. Photodynamic therapy is another aspect of laser medicine that has been used in veterinary oncology. Laser lithotripsy for both large and small animal applications is being investigated. Other clinical applications include minimally invasive techniques for ablating intervertebral discs in dogs and palliative treatment of ocular squamous cell carcinoma in cattle. Finally, low level laser therapy has been used for a number of conditions in both large and small animals. With increased interest for use of lasers in veterinary medicine, it's hoped that objective evaluation of the technology from both laser manufacturers and the profession will continue.

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AN EDUCATOR'S JOURNEY TO LASER NURSING

Dale Goodwin
Genesee Valley Laser Centre

This presentation will chronicle the evolution of the laser nurse role through a personal journey of an educator. With illustrations of how participation in the team effort of doctor and nurse in patient care progressed to the emergence of a new nursing role of laser practitioner and back full circle to educator. A review of this nurse/educator's presentations over the last ten years will illustrate this evolution. The future of laser nursing in this society depends on recognition of the doctor/nurse team approach and the new role of laser nurse practitioner and their unique educational needs.

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ASLMS AND THE INTERNET

Dr. Bryan Shumaker, Chair, ASLMS Electronic Communications Committee
Nancy Nielsen, President, Gray Communications Inc.

The ASLMS web site has been entirely revised in its design and personal member web pages are now available to members for a fee of $75 US$ (first year) and $50 for each subsequent year. Personal member pages have been made available to members so they may advertise their practice or business to the public on the new ASLMS web site. The authors will demonstrate member web page templates.

The purpose of the site revision was to employ a more pleasing graphic design and considerably increase traffic to the site. Formerly, the ASLMS site could not be found by the Internet search engines.

With the addition of special HTML language to help the search engines locate the new site, site traffic reached 1100 site visitors per week in the first 3 weeks the new site was online. A greater increase can be expected once the site is registered with all the search engines.

Increased site traffic benefits both the public and ASLMS members: the public benefits in that they can more easily access valuable information about the ASLMS and the services it provides; ASLMS members with personal web pages attached to the site benefit from the high volume of site visitor traffic visiting their personal member page.

A personal web page on the ASLMS site will permit members to reach potential clients in numbers that equal those reached by yellow pages ads - for a fraction of the cost.

With the availability of member pages and the addition of valuable public information, members can expect the new ASLMS site to be an excellent source of referrals for their practice or business.

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LASER TISSUE WELDING:
Global Applications and Future Directions

Dix P. Poppas, Pediatric Urology Center, New York-Presbyterian Hospital – Weill Medical College of Cornell University

Laser tissue welding - an emerging technology, has potential applications to all surgical fields. The capability for laser energy to induce wound closure by photothermal ligation has been demonstrated in several model systems. This talk will highlight several potential mechanisms involved in laser mediated wound repair, the development of protein solders for laser welding, the use of remote temperature control for precise thermal modulation during welding, and recent improvements in albumin solder incorporating human recombinant growth factors and other biological modifiers. Considerations will be offered regarding the future of laser welding and what can be done to help move this method of wound closure into broader clinical applications.

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SPECTROSCOPIC DIAGNOSIS IN MEDICINE

Irving Itzkan

Laser Biomedical Research Center, MIT, Cambridge, MA

Spectroscopy has the potential to perform real-time diagnosis of tissue *in situ*. We will review the three major approaches being studied today; reflectance, fluorescence and Raman scattering, and the information each provides. State-of-the-art systems and multivariate analysis techniques required for extracting diagnostic information from spectra will be described.

Optical spectroscopy has the potential to provide information about tissue without the need to remove it from the body for processing. Light can be delivered and collected via optical fibers incorporated into catheters, endoscopes, cannulas or needles to access the interior of the body, and signals can be processed in real time. Reflectance can give information about changes in blood concentration, oxygenation, optical parameters, and nuclear size distribution. Fluorescence can detect changes in chemical composition due to disease processes, and Raman spectroscopy provides the most detailed information about the chemical composition of the tissue.

There are conditions for which biopsy cannot be performed, such as coronary artery disease or Alzheimer's disease. Here spectroscopy offers the prospect of performing real time *in vivo* tissue analysis.

Illustrative examples from cancer studies, coronary artery disease studies, Alzheimer's disease brain tissue measurements, and blood analyte measurements will be presented. The issues involved in implementing spectroscopy in clinical applications, and directions for future study will be considered.

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LASERS IN SPACE EXPERT PANEL
Mike C. Muckerheide, Milwaukee, WI
David A. Wilcox, GSFC/WFF, Wallops Island, Virginia
Daniel P. Glavin, Scripps Institute of Oceanography, La Jolla, CA
Darrell L. Seeley, Milwaukee School of Engineering, Milwaukee, WI

This panel of experts will discuss the potential that exists in the field of lasers in space. Laser applications in the medical and surgical arena are dependent on cutting edge technology. Space offers an environment not possible on the Earth. Micro gravity, cosmic radiation, extreme temperature changes and high vacuum present unique conditions in which new technology can be developed. There will be discussion of the scientific disciplines, which offer the greatest potential in developing laser systems for future medical and surgical applications. Space developed systems will offer major technological advances as we move into the 21st century and insights into this arena of discovery will be addressed.

The National Aeronautics and Space Administration's Small Self-Contained Payload (SSCP) Program, otherwise known at the Get Away Special (GAS) Program, provides an opportunity for domestic and international organizations or individuals to fly a small experimental payload on board the Space Shuttle. The experiment housed within the GAS canister can weigh 60 pounds to 200 pounds, with a volume of either 2.5 cubic feet or 5.0 cubic feet. The cost of flying the experiment ranges from $3,000 to $27,000. The user must supply their own power system (batteries), internal structure, and experiment control and data management systems. Limited mechanical and electrical interfaces can be provided, as well as optional services such as a motorized door or an optical window. Further information regarding opportunities for small shuttle-borne experiments will be discussed at the meeting. More general information is available at the Get Away Special web site at
http://www.wff.nasa.gov/~sspp/gas/gas.html

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SKIN LASER SURGERY: REVOLUTIONIZING THE TREATMENT OF SKIN DISORDERS

Jeffrey S. Dover M.D., FRCPC
Department of Dermatology, Beth Israel Deaconess Medical Center, Harvard Medical School

Lasers were first developed in 1964 for industrial uses, such as precise cutting of metals and plastics. For the next 20 years, all medical laser treatments were performed using industrial lasers that had been adapted for medical use. These lasers emitted continuous beams of light and were primitive and non-specific in their actions. The development of short-pulsed lasers, which capitalize on the concept of selective photo-thermolysis, have revolutionized the treatment of skin disorders. Highly-selective cutaneous damage can be achieved resulting in effective treatments for vascular anomalies, pigmentary disorders, photoaging, scarring and excessive hair.

The pulsed dye laser has revolutionized the treatment of a variety of blood vessel abnormalities, in particular, port wine stains, hemangiomas, as well as scars, striae and warts. Short pulsed, nano-second domain lasers effectively treat disorders of pigmentation such as lentigines and nevus of Ota, café-au-lait macules and tattoos. Longer pulse duration lasers effectively target hair resulting in permanent hair growth reduction. By confining the insult superficially, by limiting heat conduction, and by vaporizing tissue with little residual thermal injury, skin can be effectively and safely resurfaced. Using CO_2 and/or Erbium:YAG lasers, skin resurfacing is effective for rejuvenating patients with sun-induced skin damage wrinkles and also for smoothing the textural change of acne scarring. Compared to chemical peels, laser skin resurfacing is more precise, results are more impressive and side effects are no more frequent.

Pulsed lasers and understanding laser tissue interactions have reshaped our ability to treat skin disorders.

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UNSOLVED PROBLEMS IN LASER APPLICATIONS

R. Rox Anderson, Harvard Medical School, Boston MA

In the Darwinian medical-technology jungle, lasers are often strong competitors capable of extremely precise surgery (e.g., laser refractive surgery), target-selective treatments (e.g., hair removal), rapid diagnostics and very high-resolution imaging (e.g., OCT and confocal microscopy). Impressive -- but what problems limit development of laser medicine? Three will be discussed. (1) Target-selective surgery is highly desirable and certainly possible with lasers. Dermatology uses "selective photothermolysis", which is limited to pigmented targets, and ophthalmology uses precise laser pointing. However, the potential for target-selective treatment seems to be well beyond present applications. How can a host of non-pigmented targets over large areas of tissue be treated with precision? Industry routinely uses lasers for extremely precise, high-speed material processing. What we lack is not the lasers, but appropriate sensing, feedback, and beam delivery systems. (2) Photochemistry is a limitless arena for medical applications. Light-absorbing drugs have been used for millenia, and recently in combination with lasers for photodynamic therapy. Light is an ideal tool for local control over drug, gene, antigen, or cytokine release. However, the photosensitizers we use are still classical compounds, precursors and derivatives. Molecular drug design should be applied to photodynamic therapy. (3) Technical progress with laser confocal microscopy, optical coherence tomography, diffuse optical tomography, and hyperspectral imaging is impressive. Bedside laser imaging could potentially diagnose disease, guide surgery, monitor responses, and control other devices. Acceptance into medicine will be impeded, however, by the need for training and by established paradigms for pathology and radiological imaging. Should bedside biopsies be read "on-line"?

TISSUE WELDING/ UROLOGY

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LASERS IN UROLOGY: PAST, PRESENT AND FUTURE

Barry S. Stein, Brown University School of Medicine, Providence, RI

In 1983, there were very few urologists utilizing lasers in their practices. The applications were largely limited to superficial bladder tumors and condyloma acuminata. The major wavelengths in use were Nd:YAG and CO2. Attempts were made to use the laser for prostatic surgery, either using the bare fiber to cut or vaporize the prostate, or place the fiber through a modified resectoscope.

Further developments in ureteroscopic techniques brought stone disease into the laser fold. Pulsed dye or Nd:YAG laser fibers were placed through cystoscopes and used to break up stones. Additionally, a bare Nd:YAG fiber could be passed through the ureteroscope to treat ureteral or renal pelvic transitional cell tumors. Laser welding, usually utilizing a low power CO2 laser, was tried for vas reanastomosis. Hematoporphyrin-dye systems showed great promise for the treatment of transitional cell tumors of the bladder, particularly for chemotherapy resistent disease. Today, the role of the laser is far less than in the past. In some institutions, such as our own, superficial bladder tumors are still routinely treated with the laser. Many urologists use the laser to fragment ureteral stones, and it is likely the safest of the instruments to do this. Many attempts have been made to use the laser to treat BPH. The Ho:YAG laser shows promise, but some problems remain to be worked out.
For the future, newer wavelengths can be anticipated. The ideal laser for treating the prostate would be in the vaporization area of the curve, rather than the coagulation zone. Safer photosensitizers are in development as well. The future holds yet greater promise for laser treatment in urology.

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CONTACT LASER ENDOSCOPIC SURGERY FOR PATIENT TO RELIEVE URINARY OUTFLOW OBSTRUCTION
Inder Perkash
VA/Stanford University Medicine Center, Palo Alto, CA
This study presents the technique and results of using Nd:YAG firing crystal tips for endoscopic urologic surgery.
Two-hundred and sixty-one procedures were performed in 205 patients: Transurethral sphincterotomy (TURS) in 99 patients, transurethral prostatectomy (TURP) and or bladder neck incisions (TUIP) in 35 patients, ablation of stricture in 50 patients, and TURS and TUIP in 21 patients. Contact laser crystal chisel tip firing Nd:YAG laser was used for TUIP, TURS and initial subsurface button hole incisions in the prostate (1). Later prostate was vaporized using a bent round crystal tip (vapormax, SLT) to achieve an adequate channel.
There was minimal (less than 50 ml) to nil blood loss during surgery and also there was no incidence of delayed secondary bleeding following these procedures. There were 22 patients (9.4%) where TURS was repeated 1-3 times. Stricture was relasered in 6 (12%) patients in 1 to 7 years after the first laser surgery; two patients with a stricture were completely closed and the other 4 needed further opening. Patients were discharged in 24 to 48 hours when the uretheral catheter was also removed
Contact laser endoscopic surgery is optimal for treating bladder outflow obstruction with minimal to nil blood loss and no incidence of secondary bleeding. There is also no risk of hyponatraemia since normal saline is used as an irrigating fluid.
Reference:
Perkash, I.: Use of contact laser crystal tip firing Nd:YAG to relieve urinary outflow obstruction in male neurogenic bladder patients. J. Clin. Laser Med. & Surg., 16:1, 33-38, 1998.

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INTERSTITIAL LASER COAGULATION FOR BPH WITH THE INDIGO 830E-1YEAR RESULTS.
Richard L. Conn and David N. Robbins, Lovelace Health Systems, Albuquerque, New Mexico.

This study will evaluate the clinical progress of approximately 50 patients treated for BPH with Interstitial Laser Coagulation over a 12 month period. The patients were treated using the Indigo 830E at Lovelace Healthcare Systems in Albuquerque, New Mexico. The Indigo 830E is a diode powered laser which uses interstitial thermal therapy techniques to create coagulation necrosis of the prostate tissue. The laser probe is introduced through standard cystoscopy equipment and positioned under direct visualization. We reviewed the patient's AUA symptom score, maximum uroflow, and residual urine volume to document clinical progress at 3,6 and 12 month periods. The patients in this study are divided into those who were not in urinary retention and those who were. Urinary retention was defined as the need for a catheter preoperatively. The preoperative post void residuals ranged from 24 cc to 800 cc. There was no incidence of blood transfusion, impotence, or retrograde ejaculation in any of the patients. All patients in the study were treated on an outpatient basis. The data suggests that Interstitial Laser Coagulation of the Prostate results in a doubling of the uroflow, halving of the post void residual, and halving of the AUA Symptom Score. This study provides both subjective and objective evidence that Interstitial Laser Coagulation is an effective treatment option for BPH. Interstitial Laser Coagulation of the prostate seems to meet the need of a large segment of the population who need to stop medical therapy, either because of side effects or lack of efficacy, and those who do not need the complete tissue removal of a TURP. The low complication risk and outpatient treatment technique provides a cost effective and safe therapeutic model for patients with BPH.

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KTP LASER VAPORIZATION PROSTATECTOMY
Reza S. Malek, Mayo Clinic, Randall S. Kuntzman, Grand Rapids, MI
We present our continuing experience of up to two years with potassium-titanyl-phosphate (KTP) laser vaporization prostatectomy Transurethral noncontact vaporization prostatectomy was performed with 60-W KTP laser in 52 men with obstructive benign prostatic hyperplasia. Mean prostatic volume was 43 ± 14 ml. KTP laser vaporization created a TURP-like cavity rapidly and easily, with minimal or no blood loss. All 52 men were outpatients and became catheter-free in less than 24 hours. Outcomes at 3, 6, 12, and 24 months are as follows:

	AUA Score	% improv	Q max (mL/s)	% improv	PVR (mL)	% improv
Preoperative (n=52)	22±5		7.9±2.4		151±93	
Postoperative 3 mos (n=44)	5.6±2.7	74%	28.6±10.8	260%	51±51	66%
Postoperative 6 mos (n=38)	4.5±2.7	79%	26.9±9.7	257%	44±34	71%
Postoperative 12 mos (n=32)	4.1±2.3	82%	27.5±11.4	227%	55±48	60%
Postoperative 2 years (n=7)	4.1±1.0	76%	32.4±13.4	297%	33±35	73%

All patients remained satisfied with their voiding outcome, which changed significantly ($P < 0.0001$). Complications included mild transient dysuria in 6%, bladder neck contracture in 2%, and delayed hematuria in 4%. None of the patients had recatheterization, reoperation, incontinence, or newly developed impotence. Of the sexually active patients, 15% and 20% had retrograde ejaculation at 1 and 2 years, respectively. Our 2-year experience indicates that 60-W KTP laser vaporization prostatectomy is safe and effective for quickly relieving bladder outlet obstruction with minimal postoperative complications, a high rate of patient satisfaction, and generally durable good outcome.

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COMPUTER SIMULATION OF PHOTODYNAMIC THERAPY OF THE PROSTATE.

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Photodynamic therapy (PDT) is an emerging minimally invasive treatment that can be employed in many human diseases including prostate cancer. This treatment of human cancer depends on the localization of a drug (photosensitizer) into the prostate. Later on, the photosensitizer is activated by high-energy laser light and the active drug destroys cancerous tissue. The success of PDT depends on precise placement of light diffusers in the prostate. Since the prostate is irregular in shape, with different dimensions, a transurethral light delivery that is circular in distribution cannot be used in most cases of carcinoma of the prostate. Sources of light and their spatial distribution must be tailored to each individual patient. More uniform, therapeutic light distribution can be achieved by interstitial light irradiation. In this case, the light is delivered by diffusers placed within the substance of the prostate volume parallel to the urethra and at a distance optimized to deliver adequate levels of light and to create the desired photodynamic effect. For this reason, we have developed a computer program that can calculate the distribution of energy depending on the number of light sources placed in the prostate, their position in the gland, the dimension of the prostate, and the attenuation coefficient. A patient's three-dimensional prostate model is built based on ultrasound images. Then the computer predicts the best set of parameters and position of light diffusers in space, displays them in graphical form or in numerical form. The program is amenable for interfacing with robotic treatment systems. Results of PDT on canine model have been found to be significantly similar to those generated by PDT simulator. Therefore, PDT simulator provides a viable technique for predicting the outcome of PDT and establishes a platform for future automation of PDT. This work was supported in part by grants from: OAI/NASA, OBR Research Challenge Grant and Stranahan Fund for Laser Research.

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PHOTOACOUSTIC TECHNIQUE FOR THE MEASUREMENT OF OPTICAL PROPERTIES OF URINARY CALCULI

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The Ho:YAG laser (λ = 2.12 μm) has been used extensively in clinical laser lithotripsy. With a 250-μs pulse duration, this mid-infrared laser fragments common urinary calculi with minimal thermal damage to adjacent soft tissues. Previous studies suggest that the fragmentation efficiency of urinary calculi depends on their optical properties. Thus, knowledge of calculus optical properties can be used to optimize the fragmentation process. Photoacoustic technique provides a means by which the optical properties of calculi can be determined.

Urinary calculi of different compositions were mounted on an acoustic transducer (rise-time = 3.5 ns) with glycerol as the impedance-matching liquid between the sensor and the sample. Q-switched Nd:YAG (λ = 1.06 μm) and Ho:YAG lasers with a pulse duration of 500 ns were used as the sources for acoustic excitation. These short laser pulses ensured stress confinement, which was required to produce an undistorted bipolar stress wave. The acoustic transient (decay slope) and the amplitude of the bipolar stress wave were used to deduce the absorption coefficients and the reduced scattering coefficients of the urinary calculi.

An optical parametric amplifier (OPA) will be tested as a novel light source for measuring the optical properties of urinary calculi over the 2- to 10-μm wavelength range.

Measured absorption coefficients correlate well with previously published data on relative absorption. The photoacoustic technique has the advantage of measuring the absolute values of absorption coefficients of urinary calculi.

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FLUORESCENCE IMAGING OF BLADDER CANCER USING 5-AMINOLEVULINIC ACID (5-ALA) – 1012 CYSTOSCOPIES

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The study evaluates the advantages and limitations of fluorescence cystoscopy (FC) after intravesical instillation of the heme-precursor 5-aminolevulinic acid (5-ALA) compared to standard white light cystoscopy.

During the past 4 years, 1012 FCs have been performed in Munich for the detection of bladder cancer. Fluoresoence imaging was performed 2-4 hours after instillation of 50 ml of a 3% solution of 5-ALA into the bladder with an incoherent light source filtered for efficient PPIX excitation (blue light, 380-440 nm) (D-Light/AF, K. Storz, Tuttlingen, FRG) and cystoscopes partially blocking reflected excitation light to enable fluorescence evaluation by a red/blue color contrast. 2475 evaluable biopsies had been taken from 605 patients in 1012 FCs.

In 32.6% of all biopsies taken, a positive histology (> dys II) was obtained. 24.2% of these biopsies had been taken only due to the positive fluorescence, the corresponding lesions would have been overlooked in standard cystoscopy. CIS was diagnosed in 17.9% of positive biopsies, 47.2% of these could be localized by fluorescence only. False positive findings were obtained from 49.6% of all biopsies, false negatives in 2.1%. No side effects could be observed.

The potential of fluorescence cystoscopy with 5-ALA to localize bladder cancer with high sensitivity could be confirmed on a high number of endoscopic investigations. The procedure proved to be applicable and profitable in daily clinical routine.

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LASER-ASSISTED DEMUCOSALIZED GASTROCYSTOPLASTY WITH AUTOAUGMENTATION IN A CANINE MODEL

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Purpose: Laser-assisted demucosalized gastrocystoplasty with autoaugmentation has been performed comparing two lasers, a 1.9 μm diode and a 1.32 μm Nd:YAG, for tissue welding.

Methods: A 1.9 μm diode laser was compared to a 1.32 μm Nd:YAG with and without thermal control using 18 female mongrel dogs with a 50% albumin solder. In vivo canine bladder capacity measurements were performed on days 4 and 14. Samples of the anastomotic area were tested for tensile strength and histology was documented.
Results: Bladder volume significantly increased in the 4 day group. Both the 1.9 μm diode laser and suture control 14 day repairs had significantly more tensile strength than their 4 day counterparts, while the 1.32 μm Nd:YAG groups did not. The suture controls had evidence of minor tissue devitalization at the anastomosis at both 4 and 14 days. The 1.32 μm laser showed primarily severe tissue injury. The laser groups at 14 days showed an inflammatory reaction that was localized to the albumin.
Conclusion: Demucosalized gastrocystoplasty with autoaugmentation was successfully performed with a 1.9 μm diode laser with results similar to sutures, while the 1.32 μm Nd:YAG had inferior results.

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SUTURELESS LASER TISSUE SOLDERING FOR HYPOSPADIAS REPAIR: LONG-TERM RESULTS OF A PROSPECTIVE CLINICAL TRIAL. Andrew J. Kirsch, Christopher S. Cooper, John M. Gatti, Hal C. Scherz. *Children's Healthcare of Atlanta, Emory University School of Medicine, Atlanta, GA, and University of Iowa School of Medicine, Iowa City, IA*

Purpose: Laser tissue soldering (LTS) is a safe and effective method of tissue closure resulting in minimal scar formation. The purpose of this study was to compare the results of LTS to conventional suturing for hyposadias repair.
Methods: A consecutive group of 108 boys, ages 4 mo to 8 yrs (mean 15 mo.) were divided between standard suturing (N=68) or "sutureless" laser hypospadias repair (N=40). Urethral repairs were defined as simple (Thiersch-Duplay or Snodgrass, N=75) or complex (onlay island flap or tube, N=33). LTS was performed with a 50% human albumin solder doped with ICG dye using an 808 nm diode laser (P=0.5W). In the laser group, sutures were used for tissue alignment only. At surgery, neourethral and penile lengths, operative time for neourethral construction, and number of sutures or throws were measured. Postoperatively, patients were examined for complications of wound healing, stricture or fistula formation.
Results: Mean age, severity of urethral defect, type of repair, neourethral length, and stent time were not significantly different between the two groups. Operative time was over five times faster for LTS in both simple (1.6 ± 0.1 min, $p<0.001$) and complex (5.2 ± 0.3 min, $p< 0.001$) repairs vs. controls (8.3 ± 0.8 min and 26.0 ± 1.6 min, respectively). The mean number of sutures for tissue alignment in the laser group for simple and complex repair (3.0 ± 0.2 and 8.2 ± 0.6, respectively) was significantly ($p<0.001$) less than control groups (8.5 ± 0.8 and 23.2 ± 1.5, respectively). Followup ranged from 5-34 months (mean 24 mo). The complication rate was 5% (2/40) in the laser group (2 fistulas) and 10% (7/68) in controls (5 fistulas, 2 meatal stenoses).
Conclusions: These results indicate that sutureless laser tissue soldering is a safe and effective method of tissue closure in children undergoing hypospadias repair. The ease of the laser technique, improved wound healing, and the lower complication rate in the laser group compares favorably to standard suturing.

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SEMI-SOLID ALBUMIN SOLDER FOR LASER TISSUE WELDING

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Purpose: A semi-solid albumin solder made with hydroxypropylmethylcellulose (HPMC) was designed to improve the characteristics of liquid and solid solders.

Methods: Acute breaking strengths were determined on canine small bowel using liquid 50% bovine serum albumin (BSA), semi-solid 48% BSA with HPMC, and solid 60% BSA solder. Long term healing of liquid and semi-solid solders, compared to a suture control, was evaluated in a porcine skin model, with breaking strength and histology obtained on day 7.

Results: Acutely, semi-solid solder had a significantly [$p<0.05$] higher tensile strength than liquid and solid solder. At 7 days HSA semi-solid had significantly [$p<0.05$] higher tensile strength than suture control, however no differences were seen between semi-solid and liquid solder groups with respect to breaking strengths or histology in a porcine skin model.

Conclusions: Acutely, semi-solid solder was stronger than the current standard of 50% liquid albumin with better handling characteristics.

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COMPARISON OF WELDING CHARACTERISTICS OF DIFFERENT ALBUMIN SPECIES WITH AND WITHOUT FATTY ACIDS

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Purpose: The breaking strength of four different species of serum albumin (human, bovine, porcine, and canine) both with and without fatty acids were evaluated to determine the welding ability of each type of albumin.

Methods: Acute breaking strengths were determined on canine small bowel using 50% albumin from human, bovine, porcine, and canine serum albumin both with and without fatty acids.

Results: Bovine serum albumin (BSA) and fatty acid free bovine serum albumin (BSA-FAF) had a significantly higher [$p<0.05$] breaking strength than all groups; however, BSA was significantly higher [$p<0.05$] than BSA-FAF. There was no significant difference in breaking strength when fatty acid free albumin was compared to fatted albumin in humans, pigs, or dogs. Fatty acid free porcine serum albumin had significantly higher [$p<0.05$] breaking strength than canine serum albumin (CSA) both with and without fatty acids. Fatty acid free human serum albumin had significantly higher [$p<0.05$] breaking strength than CSA.

Conclusions: These experimental results show that species specific and fatty acid specific differences exist when these albumin solders are used for laser tissue welding.